FINAL REPORT

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GRANT NAG 5-1526 FINAL REPORT

"ROSAT and Radio Observations of Stellar Flares on AD Leo"

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This final report is on our investigations of the flare star AD Leo that were motivated by the opportunity to observe with the ROSAT satellite. The investigations were made under the auspices of NASA Grant NAG 5 1626, University of Colorado number 1533121. The observations of the flare star AD Leo were carried out by Rosat on 8–9 May 1991. Contemporaneous observations were made with a large number of optical and radio telescopes around the world, and with Ginga, the Hubble Space Telescope (HST) and the International Ultraviolet Explorer (IUE), resulting in the most extensive observing campaign ever carried out on a flare star.

About 70% of the data from ROSAT were ever received; the remaining 30% are missing or unrecoverable for unknown reasons.

The x-ray light curves show that one flare with about 15 counts per sec was observed at 1548 UT on 8 May 1991, and another may have been observed at 0800 on 9 May 1991. Another flare was observed at about 0300 UT on 9 May 1991, apparently lasting about two hours. The flare of 8 May, 1548 UT, was also recorded by Ginga in the 10–20 keV band, making it the first flare observed simultaneously at two distinctly different x-ray energies. The flare of 9 May, 0300 UT, was observed with the Very Large Array (VLA) at two wavelengths. Since radio data reflect the presence of $\gtrsim$ 100 keV electrons, something about the relative numbers of 1- and 100-keV electrons could be derived. This is the first time that such simultaneous data have been available. Other instruments on the ground observed other flares than these, demonstrating that x-ray flares are not always accompanied by optical, UV or radio emissions, and vice versa. HST observed one flare with very rapidly varying UV lines.

Observations with other instruments include:

1. A small flare was seen in photometry, Hα, and He I at about 0315 UT on 8 May, with IUE possibly observing the decay phase.

2. HST observed this flare and recorded unprecedentedly rapidly varying UV lines, down to 1 s.

3. Five nights of good quality IR data permitting the magnetic field of AD Leo to be determined, and crude maps to be constructed.

4. Possible flares were seen in the UV at 1545 UT on 8 May, and 0040 UT and 0240 UT on 9 May.

5. In the radio band there were possible flares at 2250 UT and 2315 on 9 May. In particular, a flare of about 30 mJy was recorded by the Arecibo telescope at 2237 UT on 9 May, lasting about 30 s.

6. Three days of excellent observations at 3 mm with the IRAM interferometer on the Plateau de Bure, France, show a complete absence of flux from AD Leo. On the timescale of quiescent emission (a few hours) the limit is a few milliJansky. On a 10-minute timescale, the limit is about 20 mJy.

The quantitative analysis of these two data sets were initiated, and a manuscript was in preparation, but neither were completed. For technical reasons, the hard x-ray data from Ginga never became available and, hence, could not be combined and compared with the soft x-ray data from ROSAT. In addition, the missing data from Rosat constitutes a significant gap and this data, in conjunction with the Ginga data were essential for completing further publications of significant scientific interest.

A preliminary report on the data and observations was presented by J. Bookbinder and others at the Seventh Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, Tucson, Arizona, in October 1991.

No inventions or patents were generated as a result of this research.